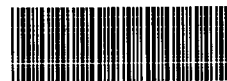


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WORK PLAN FOR A  
HYDROGEOLOGIC STUDY AT THE  
MERCK SHARP & DOHME PLANT,  
WEST POINT, PENNSYLVANIA

Prepared by:

(b) (4)

Certified Professional Geologist No. 6324

Nittany Geoscience, Inc.

1523 Science Street

State College, PA 16801

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EXHIBIT A

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## INTRODUCTION

### Background

Merck Sharp & Dohme (MSD) has been investigating groundwater quality at its West Point, PA facility, and numerous actions have been taken to abate soil and groundwater pollution and to prevent the spread of pollutants. Investigatory, abatement, and response actions have included monitoring well construction (12), soil sampling and soil-gas surveying, monitoring well geophysical logging and packer/pump testing, tank removal, sludge residue removal, in-situ volatilization (ISV) for soil vapor extraction; pumping for groundwater control and contaminant containment, installation of carbon treatment on plant production wells, and provision of some alternate water supplies. MSD met with the Department of Environmental Resources (DER) on December 21, 1987, to present the results of work done to date and to describe future plans. During that meeting DER requested that MSD submit a hydrogeologic report.

### DER Request

In her letter of January 4, 1988, to Steve Wittmer of Merck Sharp & Dohme, Ms. Marilyn Shup, DER Water Quality Specialist Supervisor, requested that MSD take the following actions:

"No later than January 25, 1988, MSD must submit to the Department for approval a work plan (prepared by a qualified hydrogeologist) describing the scope and methods of a hydrogeologic study to determine the extent and impact of soil and groundwater contamination at and in the vicinity of the plant. The work plan should include target dates for completion of the various tasks comprising the study, including a final report and recommendations.

The scope of the study should include as a minimum:

Definition of the present extent of soil and groundwater pollution.  
(Location)

Evaluation of the potential for further spread of soil and groundwater pollution.  
(Migration)

Definition of all sources of the pollution and a description of the means and methods proposed or used for the elimination of said sources.

(Source)

Evaluation of alternatives available to abate the soil and groundwater pollution.

(Remediation)

A groundwater quality monitoring program which will allow for evaluation of long-term groundwater quality conditions and which will ensure the protection of public health.  
(Monitoring)

Conclusions and proposed actions to abate the soil and groundwater pollution and a schedule for accomplishing such actions."  
(Reporting)

Bold print style has been added to words in Ms. Shup's text for emphasis, and a one-word abstract is included in parentheses after each element of the study scope. In the following section the work scope has been organized using these one-word abstracts.

It must be emphasized that MSD has done a great deal already to identify the nature and extent of the groundwater problem at the site and that appropriate control, abatement, and monitoring measures have been implemented. The work plan which follows is intended to provide for an even more complete understanding of the situation, and MSD will continue to implement appropriate response measures during the course of this project.

The hydrogeologic study which is described in the work plan has to a very important extent been already completed, or is presently ongoing. Target dates and titles for tasks which have been accomplished at this time are printed in bold print style for emphasis.

The work plan has two milestones:

- Report of what has already been done (Phase I)
- Report of hydrogeologic study, MSD response actions completed, and MSD response actions anticipated (Phase II)

### SCOPE OF WORK

Merck Sharp & Dohme met with the Department of Environmental Resources on December 21, 1987, to present the results of work done to date to determine the location, migration, and sources of contaminated groundwater at and in the vicinity of the West Point Plant, and to describe actions taken and proposed to remediate contamination, provide alternative water supplies as appropriate, and to monitor water quality for the protection of public health. Submission of a written report of these activities and results (herein referred to as Phase I) is proposed as Task 1.0 of this work plan. Additional tasks, which comprise Phase II, include the following: Task 2.0: Determine Plume Location, Task 3.0: Evaluate Plume Migration, Task 4.0: Define Contaminant Sources, Task 5.0: Monitor and Protect Public Health, and Task 6.0: Phase II Reporting. Phase III, MSD Response Actions, falls under Task 7.0 of the work plan. This plan will be modified as necessary according to the results obtained.

The status of the work to be completed under each task is indicated with task titles.

Task 1.0: Report Phase I Findings

Complete

Findings to date will be documented in a report under this task. Elements of the report will include the hydrogeologic setting, the location, migration, and possible sources of contaminants, MSD interim response actions to address protection of public health, remediation of contamination, and monitoring for plume delineation and potable water-supply evaluation.

Task 2.0: Determine Plume Location

The geometry and size of the plume will be determined in three dimensions, and contaminant distribution and concentration will be measured.

Subtask 2.1: Contaminant Lateral Distribution

Complete/On-going

On-site contamination has been monitored in wells constructed in 1985 and 1986, and water-quality data have been collected approximately monthly for more than a year. Off-site domestic wells are being sampled in a project begun in November 1987. These water-quality data are being contoured to prepare preliminary isoconcentration maps of contaminant lateral distribution. For this task the off-site sampling will be completed, and maps prepared to include all sampled points.

Subtask 2.2: Contaminant Vertical Distribution

Complete/On-going

Electric and geophysical well logs

Five on-site monitoring wells have been logged to measure the locations of borehole-fracture intercepts, and to determine the vertical distribution of water quality in the standing water column. This information was then used to guide selection of specific well intervals for packer/pump testing. Results from the initial five wells will determine if additional monitoring wells should be tested similarly.

Packer/Pump tests

Packer/pump testing is used to pump from selected intervals in a well bore, using inflatable packers to seal off the remainder of the well. Water samples collected during each pumping interval are analyzed to determine the vertical distribution of water quality in the aquifer.

Task 3.0: Evaluate Plume Migration

Plume migration will be addressed in terms of both rate and direction under the following subtasks.

Subtask 3.1: Determine Groundwater Flow Rate Complete/On-going

On-site wells have been pump tested to determine aquifer hydraulic constants (hydraulic conductivity and storage). Values of hydraulic conductivity so obtained will be used with measured hydraulic gradients from water-level maps, and values of the aquifer's effective porosity to calculate groundwater seepage velocities.

Subtask 3.2: Determine Groundwater Flow Paths

Paths of groundwater flow will be determined by (1) analysis of site hydrogeologic setting, (2) fracture-trace analysis, (3) installation of additional monitoring wells and/or piezometers, as appropriate, and (4) study of isoconcentration maps.

Analysis of site hydrogeologic setting

Complete/On-going

Site-specific, local, and regional hydrogeologic information will be compiled to provide the context for natural groundwater flow, and perturbations of that flow system by pumping wells.

Fracture-trace analysis

Complete

Fracture-trace analysis was used to site an MSD production well (PW-8) in 1979. Fractures are favorable avenues for groundwater flow in these otherwise hydraulically tight rocks. Pre-construction photos, if available, will be obtained for mapping fracture traces at and near the MSD site without the obscuring effect of plant facilities on the photos.

Additional monitoring wells/piezometers

On-going

Efforts to determine contaminant migration pathways may require construction of additional monitoring wells and/or piezometers.

Preliminary Isoconcentration maps

Complete

Contaminants can to some extent serve as tracers for groundwater flow. Maps of water quality portray patterns reflecting that flow.

Task 4.0: Define Contaminant Sources

Contaminant sources may be located by (1) evaluating water-quality patterns, (2) reviewing the history of plant activities, (3) performing soil-gas surveys, and (4) sampling soils for analysis.

Subtask 4.1: Evaluate Water-Quality Patterns

Complete/On-going

Water-quality patterns on preliminary isoconcentration maps are being used to guide efforts to identify contaminant sources in the subtasks listed below.

Subtask 4.2: Review History of Plant Activities Complete/On-going

Plant history is under review, especially in regard to activities which took place at or near the locations of "hot spots" on the isoconcentration maps.

Subtask 4.3: Perform Soil-Gas Survey On-going

Two episodes of soil-gas surveying have been undertaken thus far in an effort to prospect for contaminants in site soil. Additional soil-gas prospecting will take place, as appropriate.

Subtask 4.4: Conduct Soil Boring and Sampling On-going

Soil sampling will be used to verify and define contaminant source areas. Sample locations will be determined based upon the results of the three subtasks above.

Task 5.0: Monitor and Provide for Public Health Protection

Activities in this task were initiated as MSD response actions. Provisions for public health protection have been completed, and monitoring is on-going.

Subtask 5.1: Provide Alternate Water Supplies Complete/On-going

Domestic well which did not meet drinking-water quality standards were temporarily replaced with bottled water, and are being permanently replaced by hookup to the municipal water supply.

Subtask 5.2: Provide Carbon Treatment Complete

MSD supply wells have been provided with carbon-filtration treatment.

Subtask 5.3: Monitor NW-7 Municipal Supply On-going

One municipal supply well, North Wales Water Authority Well Number 7 (NW-7), is in close proximity to the MSD site. Samples from this well have been free of contamination, and monthly monitoring of NW-7 is on-going.

Subtask 5.4: Monitor for Domestic Supply Protection On-going

A domestic-well sampling program has identified areas of contaminated groundwater in the vicinity of the MSD site. Alternative water supplies have been provided to owners of wells not meeting drinking-water standards. An on-going monitoring program is being designed to allow continued use of wells which presently meet drinking-water standards, while assuring that any shift in plume location would be detected prior to its impact on the water quality of a supply well.

## Task 6.0: Phase II Reporting

### Subtask 6.1: Monthly Technical Reports

On-going

Monthly reports will be submitted to MSD detailing (1) work performed, (2) problems encountered, and (3) work planned for the coming month. Reports of specific Phase II task activities will be submitted as attachments to monthly technical reports, as appropriate.

### Subtask 6.2: Phase II Final Report

On-going

To Be Completed

Phase II activities and results will be documented in a final report. The nature and extent of soil and groundwater contamination as determined by Phase II tasks will serve as the basis for identifying alternatives available for remediation. The final report will include the following elements:

- Plume location
- Plume migration
- Contaminant sources
- Remedial alternatives
- Monitoring and public health protection

Target date anticipates the possible need to install additional monitoring wells that will require testing and interpretation of data in comparison with prior testing results.

## Task 7.0: Phase III - - MSD Response Actions

A number of response actions have already been taken by MSD, as described in the December 21, 1987 meeting with DER, and as will be documented in the Phase I report of Task 1.0. MSD will continue to implement appropriate response measures during the course of this project. However, following the thorough investigation of Phase II described above, Phase III activities will (1) evaluate remedial alternatives for permanent contamination abatement, and (2) continue monitoring for public health protection and measurement of remediation effectiveness.

### Subtask 7.1: Evaluate Remedial Alternatives

On-going

To Be Completed

Alternative remedial measures, including those in place or developed while the investigation proceeds, will be evaluated based upon availability of technology, impact of interim measures, availability of regulatory guidance, and the potential impact on human health and the environment.

### Subtask 7.2: Monitoring

On-going and As

Appropriate

Monitoring under this subtask will assure public health protection, and will measure the effectiveness of remedial measures.